

## CLAIMS

1.           A magnetic random access memory comprising:  
            a plurality of first signal lines provided to  
extend in a first direction;  
5           a plurality of second signal lines provided  
to extend in a second direction substantially  
perpendicular to said first direction;  
            a plurality of memory cells respectively  
provided at intersections of said plurality of first  
10 signal lines and said plurality of second signal  
lines; and  
            a plurality of magnetic structures  
respectively provided for said plurality of memory  
cells,  
15           wherein each of said plurality of memory  
cells comprises a magneto-resistance element  
containing a spontaneous magnetization layer which has  
a first threshold function, and a direction of a  
spontaneous magnetization of said spontaneous  
20 magnetization layer is reversible when an element  
applied magnetic field equal to or larger than a value  
of the first threshold function is applied,  
            each of said plurality of magnetic structures  
has a second threshold function, and generates a  
25 magnetic structure magnetic field in response to a  
structure applied magnetic field, and generates a  
third magnetic field as said magnetic structure

magnetic field when said structure applied magnetic field is equal to or larger than a value of a second threshold function, and a fourth magnetic field, which is weaker than said third magnetic field, as said  
5 magnetic structure magnetic field, when said structure applied magnetic field is less than the second threshold function value,

a first write current is supplied to one of said plurality of first signal lines as a first  
10 selected signal line such that a first magnetic field is generated, a second write current is supplied to one of said plurality of second signal lines as a second selected signal line such that a second magnetic field is generated, and a first synthetic  
15 magnetic field of said first magnetic field and said second magnetic field is applied to said plurality of magnetic structures as said structure applied magnetic field, and

a second synthetic magnetic field of said  
20 first synthetic magnetic field and said magnetic structure magnetic field is generated as said element applied magnetic field such that said element applied magnetic field equal to or larger than the first threshold function value is applied to a selected  
25 memory cell provided at the intersection of said first selected signal line and said second selected signal line, and such that said element applied magnetic

field less than the first threshold function value is applied to each of non-selected memory cells as ones said plurality of memory cells other than said selected memory cell.

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2. The magnetic random access memory according to claim 1, wherein each of said plurality of magnetic structures comprises:

a first magnetic layer formed of  
10 ferromagnetic material;

a second magnetic layer formed of  
ferromagnetic material; and

a non-magnetic layer interposed between said  
first magnetic layer and said second magnetic layer.

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3. The magnetic random access memory according to claim 1, wherein said non-magnetic layer has a film thickness such that said first magnetic layer is anti-ferromagnetically coupled to said second magnetic

20 layer.

4. The magnetic random access memory according to claim 2 or 3, wherein the second threshold function is determined based on the film thickness of said non-

25 magnetic layer.

5. The magnetic random access memory according

to any of claims 2 to 4, wherein when said structure applied magnetic field is not applied, said magnetic structure magnetic field generated by said magnetic structure is substantially 0.

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6. The magnetic random access memory according to any of claims 1 to 5, wherein said first synthetic magnetic field larger than the second threshold function value is applied as said structure applied  
10 magnetic field to said magnetic structure corresponding to said selected memory cell, said magnetic structure corresponding to said selected memory cell generates said third magnetic field as said magnetic structure magnetic field, said synthetic  
15 magnetic field of said first synthetic magnetic field and said third magnetic field is applied to said magneto-resistance element of said selected memory cell as said element applied magnetic field equal to or larger than the first threshold function value, and  
20 said first synthetic magnetic field having the intensity less than the second threshold function value is applied as said structure applied magnetic field to said magnetic structure corresponding to each of said non-selected memory cells, said magnetic  
25 structure corresponding to said non-selected memory cell generates said fourth magnetic field as the magnetic structure magnetic field, and said synthetic

magnetic field of said first synthetic magnetic field and said fourth magnetic field is applied to said magneto-resistance element of said selected memory cell as said element applied magnetic field less than  
5 the first threshold function value.

7. The magnetic random access memory according to any of claims 1 to 5, wherein said first synthetic magnetic field less than the second threshold function  
10 value is applied as said structure applied magnetic field to said magnetic structure corresponding to said selected memory cell, said magnetic structure corresponding to said selected memory cell generates said fourth magnetic field as said magnetic structure  
15 magnetic field, and said synthetic magnetic field of said first synthetic magnetic field and said fourth magnetic field is applied to said magneto-resistance element of said selected memory cell as said element applied magnetic field equal to or larger than the  
20 first threshold function value, and

said first synthetic magnetic field having the intensity equal to or larger than the second threshold function value is applied as said structure applied magnetic field to said magnetic structure  
25 corresponding to each of said non-selected memory cells, said magnetic structure corresponding to said non-selected memory cell generates said third magnetic

field as said magnetic structure magnetic field, and  
said synthetic magnetic field of said first synthetic  
magnetic field and said third magnetic field is  
applied to said magneto-resistance element of said  
5 selected memory cell as said element applied magnetic  
field less than the first threshold function value.

8. The magnetic random access memory according  
to claim 6, wherein one of said plurality of first  
10 signal lines and one of said plurality of second  
signal lines are provided between a corresponding one  
of said plurality of memory cells and said magnetic  
structure corresponding to the corresponding memory  
cell, and  
15 said corresponding magnetic structure is  
provided directly or indirectly on said first signal  
line.

9. The magnetic random access memory according  
20 to claim 7, wherein each of said plurality of memory  
cells and said magnetic structure corresponding to  
said memory cell are provided between one of said  
plurality of first signal lines corresponding to said  
memory cell and one of said plurality of second signal  
25 lines corresponding to said memory cell.

10. The magnetic random access memory according

to claim 6 or 8, wherein said magnetic structure has a circular plane structure.

11.           The magnetic random access memory according  
5 to any of claims 6 to 9, wherein said magnetic structure has an elliptical plane structure.

12.           The magnetic random access memory according  
to claim 11, wherein an elliptical long axis of said  
10 magnetic structure is directed into a direction other than the first direction and the second direction.

13.           The magnetic random access memory according  
to claim 12, wherein the elliptical long axis of said  
15 magnetic structure is directed to the direction of 45 degrees from each of the first direction and the second direction.

14.           A magnetic random access memory comprising:  
20           a plurality of first signal lines provided to extend in a first direction;

              a plurality of second signal lines provided  
to extend in a second direction substantially  
perpendicular to the first direction;

25           a plurality of memory cells, each of which contains a magneto-resistance element having a spontaneous magnetization whose direction is

reversible based on data to be stored, and which are respectively provided at intersections of said plurality of first signal lines and said plurality of second signal lines; and

5           a plurality of magnetic structures which are provided for said plurality of memory cells, and each of which applies a magnetic field to said magneto-resistance element contained in a corresponding one of said plurality of memory cells based on induced  
10 magnetization,

          wherein one of said plurality of memory cells provided for the intersection of a first selected signal line selected from among said plurality of first signal lines and a second selected signal line  
15 from among said plurality of second signal lines is a selected memory cell,

          one of said plurality of magnetic structures corresponding to said selected memory cell is a selected magnetic structure,

20           one of said plurality of memory cells which is other than said selected memory cell and which intersects said first selected signal line is a first non-selected memory cell,

          one of said plurality of magnetic structures  
25 corresponding to said first non-selected memory cell is a first non-selected magnetic structure,

          a synthetic magnetic field  $H_{xy}$  applied to said

selected magnetic structure by a first write current flowing through said first selected signal line in a write operation and a second write current flowing through said second selected signal line in the write  
5 operation, said magnetization  $M_{xy}$  induced in said selected magnetic structure by said synthetic magnetic field  $H_{xy}$ , a magnetic field  $H_y$  applied to each of said first non-selected magnetic structures by said first write current in the write operation, and a  
10 magnetization  $M_y$  induced in said first non-selected magnetic structure by said magnetic field  $H_y$  satisfy the following relation:

$$M_{xy}/H_{xy} \neq M_y/H_y.$$

15 15. The magnetic random access memory according to claim 14, wherein one of said plurality of memory cells which is other than said selected memory cell and which intersects said second selected signal line is a second non-selected memory cell, and

20 one of said plurality of magnetic structures corresponding to said second non-selected memory cell is a second non-selected magnetic structure,

said synthetic magnetic field  $H_{xy}$ , said magnetization  $M_{xy}$ , a magnetic field  $H_x$  applied to said  
25 second non-selected magnetic structure by said second write current in the write operation, and a magnetization  $M_x$  induced in said second non-selected

magnetic structure by said magnetic field  $H_x$  satisfy the following relation:

$$M_{xy}/H_{xy} \neq M_x/H_x.$$

5 16. The magnetic random access memory according to claim 14, wherein said plurality of magnetic structures are arranged in positions where said magnetization  $M_{xy}$  and said magnetization  $M_y$  are induced such that a magnetic field applied to said magneto-  
10 resistance element contained in said selected memory cell by said first write current and said second write current and a magnetic field applied to said magneto-resistance element contained in said first non-selected memory cell by said first write current are  
15 enhanced, and

said magnetic field  $H_y$ , said synthetic magnetic field  $H_{xy}$ , said magnetization  $M_y$  and said magnetization  $M_{xy}$  satisfy

$$M_{xy}/H_{xy} > M_y/H_y.$$

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17. The magnetic random access memory according to claim 14, wherein said plurality of first signal lines and said plurality of second signal lines are located between said plurality of magnetic structures  
25 and said plurality of memory cells, and

said magnetic field  $H_y$ , said synthetic magnetic field  $H_{xy}$ , said magnetization  $M_y$  and said

magnetization  $M_{xy}$  satisfy

$$M_{xy}/H_{xy} > M_y/H_y.$$

18.       The magnetic random access memory according  
5 to claim 17, wherein one of said plurality of memory  
cells which is other than said selected memory cell  
and which intersects said second selected signal line  
is a second non-selected memory cell,

          one of said plurality of magnetic structures  
10 corresponding to said second non-selected memory cell  
is a second non-selected magnetic structure, and

          said synthetic magnetic field  $H_{xy}$ , said  
magnetization  $M_{xy}$ , said magnetic field  $H_x$  applied to  
said second non-selected magnetic structure by said  
15 second write current in the write operation, and said  
magnetization  $M_x$  induced in said second non-selected  
magnetic structure by said magnetic field  $H_x$  satisfy  
 $M_{xy}/H_{xy} > M_x/H_x$ .

20 19.       The magnetic random access memory according  
to claim 14, wherein said plurality of magnetic  
structures are arranged in positions where said  
magnetization  $M_{xy}$  and said magnetization  $M_y$  are induced  
such that a magnetic field applied to said magneto-  
25 resistance element contained in said selected memory  
cell by said first write current and said second write  
current and a magnetic field applied to said magneto-

resistance element contained in said first non-selected memory cell by said first write current are weakened, and

said magnetic field  $H_y$ , said synthetic  
5 magnetic field  $H_{xy}$ , said magnetization  $M_y$ , and said magnetization  $M_{xy}$  satisfy  
 $M_{xy}/H_{xy} < M_y/H_y$ .

20. The magnetic random access memory according  
10 to claim 14, wherein said plurality of magnetic structures and said plurality of memory cells are located between said plurality of first signal lines and said plurality of second signal lines, and

said magnetic field  $H_y$ , said synthetic  
15 magnetic field  $H_{xy}$ , said magnetization  $M_y$  and said magnetization  $M_{xy}$  satisfy  
 $M_{xy}/H_{xy} < M_y/H_y$ .

21. The magnetic random access memory according  
20 to claim 20, wherein one of said plurality of memory cells which is other than said selected memory cell and which intersects said second selected signal line is a second non-selected memory cell,

one of said plurality of magnetic structures  
25 corresponding to said second non-selected memory cell is a second non-selected magnetic structure, and  
said synthetic magnetic field  $H_{xy}$ , said

magnetization  $M_{xy}$ , said magnetic field  $H_x$  applied to  
said second non-selected magnetic structure by said  
second write current in the write operation, and said  
magnetization  $M_x$  induced in said second non-selected  
5 magnetic structure satisfy  
 $M_{xy}/H_{xy} < M_x/H_x$ .

22. The magnetic random access memory according  
to any of claims 14 to 21, wherein each of said  
10 plurality of magnetic structures comprises a ferri-  
magnetic laminate structure comprises:

a first magnetic layer formed of  
ferromagnetic material;

a second magnetic layer formed of  
15 ferromagnetic material; and

a non-magnetic layer interposed between said  
first magnetic layer and said second magnetic layer  
and having a film thickness such that said first  
magnetic layer is anti-ferromagnetically coupled to  
20 said second magnetic layer.

23. The magnetic random access memory according  
to claim 16 or 17, wherein each of said plurality of  
magnetic structures comprises a ferri-magnetic  
25 laminate structure comprises:

a first magnetic layer formed of  
ferromagnetic material;

a second magnetic layer formed of  
ferromagnetic material; and

a non-magnetic layer interposed between said  
first magnetic layer and said second magnetic layer,  
5 and having a film thickness such that said first  
magnetic layer is anti-ferromagnetically coupled to  
said second magnetic layer,

said synthetic magnetic field  $H_{xy}$  is larger  
than a threshold magnetic field  $H_{txy}$  of said ferri-  
10 magnetic laminate structure in a direction of said  
synthetic magnetic field  $H_{xy}$ , and

said magnetic field  $H_y$  is smaller than a  
threshold magnetic field  $H_{ty}$  of said ferri-magnetic  
laminate structure in a direction of a magnetic field  
15  $H_y$ .

24. The magnetic random access memory according  
to claim 18, wherein each of said plurality of  
magnetic structures comprises a ferri-magnetic  
20 laminate structure comprises:

a first magnetic layer formed of  
ferromagnetic material;

a second magnetic layer formed of  
ferromagnetic material; and

25 a non-magnetic layer interposed between said  
first magnetic layer and said second magnetic layer  
and having a film thickness such that said first

magnetic layer is anti-ferromagnetically coupled to said second magnetic layer,

said synthetic magnetic field  $H_{xy}$  is larger than a threshold magnetic field  $H_{txy}$  of said ferri-magnetic laminate structure in a direction of said synthetic magnetic field  $H_{xy}$ ,

said magnetic field  $H_x$  is smaller than a threshold magnetic field  $H_{tx}$  of said ferri-magnetic laminate structure in a direction of said magnetic field  $H_x$ , and

said a magnetic field  $H_y$  is smaller than a threshold magnetic field  $H_{ty}$  of said ferri-magnetic laminate structure in a direction of said magnetic field  $H_y$ .

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25. The magnetic random access memory according to claim 24, wherein anisotropy is given to said magneto-resistance element such that the direction of said spontaneous magnetization of said magneto-

resistance element is substantially coincident with the first direction, and to said ferri-magnetic laminate structure such that directions of spontaneous magnetizations of said first magnetic layer and said second magnetic layer are directed into a third direction which is not perpendicular to the first direction.

26. The magnetic random access memory according to claim 24, wherein an angle between the first direction and the third direction is substantially 45 degrees.

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27. The magnetic random access memory according to claim 25, wherein the direction of said synthetic magnetic field  $H_{xy}$  is substantially perpendicular to the third direction.

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28. The magnetic random access memory according to claim 19 or 20, wherein each of said plurality of magnetic structures comprises a ferri-magnetic laminate structure comprises:

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a first magnetic layer formed of ferromagnetic material;

a second magnetic layer formed of ferromagnetic material; and

a non-magnetic layer interposed between said first magnetic layer and said second magnetic layer and having a film thickness such that said first magnetic layer is anti-ferromagnetically coupled to said second magnetic layer,

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said synthetic magnetic field  $H_{xy}$  is smaller than a threshold magnetic field  $H_{t_{xy}}$  of said ferri-magnetic laminate structure in a direction of said synthetic magnetic field  $H_{xy}$ , and

said magnetic field  $H_y$  is larger than a threshold magnetic field  $H_{ty}$  of said ferri-magnetic laminate structure in a direction of the magnetic field  $H_y$ .

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29. The magnetic random access memory according to claim 28, wherein anisotropy is given to said magneto-resistance element such that the direction of the spontaneous magnetization of said magneto-  
10 resistance element is substantially coincident with the first direction, and to said ferri-magnetic laminate structure such that directions of spontaneous magnetizations of said first magnetic layer and said second magnetic layer are substantially coincident  
15 with the first direction.

30. The magnetic random access memory according to claim 21, wherein each of said plurality of magnetic structures comprises a ferri-magnetic  
20 laminate structure comprises:

a first magnetic layer formed of ferromagnetic material;

a second magnetic layer formed of ferromagnetic material; and

25 a non-magnetic layer interposed between said first magnetic layer and said second magnetic layer and having a film thickness such that said first

magnetic layer is anti-ferromagnetically coupled to said second magnetic layer,

said synthetic magnetic field  $H_{xy}$  is smaller than a threshold magnetic field  $H_{txy}$  of said ferri-magnetic laminate structure in a direction of said synthetic magnetic field  $H_{xy}$ ,

said magnetic field  $H_x$  is larger than a threshold magnetic field  $H_{tx}$  of said ferri-magnetic laminate structure in a direction of said magnetic field  $H_x$  and

said magnetic field  $H_y$  is larger than a threshold magnetic field  $H_{ty}$  of said ferri-magnetic laminate structure in a direction of said magnetic field  $H_y$ .

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31. The magnetic random access memory according to claim 30, wherein anisotropy is given to said magneto-resistance element such that a direction of the spontaneous magnetization of said magneto-

resistance element is substantially coincident with the first direction, and to said ferri-magnetic laminate structure such that directions of spontaneous magnetizations of said first magnetic layer and said second magnetic layer are directed into a third direction which is not perpendicular to the first direction.

32. The magnetic random access memory according to claim 21, wherein the direction of said synthetic magnetic field  $H_{xy}$  is substantially identical to the third direction.

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